

Volume 51 January–June 1985

Philosophical Magazine

First Published in 1798

Physics of Condensed Matter

- A** Defects and Mechanical Properties
- B** Electronic Optical and Magnetic Properties



Europhysics Journal



Taylor & Francis
London and Philadelphia

PHILOSOPHICAL MAGAZINE

Editor

Professor E. A. Davis

Department of Physics, University of Leicester, U.K.

Associate Editors

Dr S. R. Elliott

Department of Physical Chemistry,
University of Cambridge, U.K.

Professor A. J. Forty

Department of Physics, University of Warwick, U.K.

Dr M. J. Goringe

Department of Metallurgy and Science of Materials,
University of Oxford, U.K.

Dr P. M. Hazzledine

Department of Metallurgy and Science of Materials,
University of Oxford, U.K.

Regional Editors

Professor C. Domb

Department of Physics, Bar-Ilan University, Israel

Dr M. Duesbury

Division of Physics, National Research Council, Canada

Dr M. Kléman

Laboratoire de Physique des Solides,
Université de Paris-Sud, France

Professor K. Morigaki

Institute of Solid State Physics, University of Tokyo, Japan

Dr C. Schlenker

Laboratoire d'Études des Propriétés Électroniques des
Solides, CNRS-Grenoble, France

Professor A. Seeger

Institut für Physik, Max-Planck-Institut für Metallforschung,
Stuttgart, F.R. Germany

Dr R. A. Street

Palo Alto Research Center, Xerox Corporation, U.S.A.

Consultant Editor

Professor Sir Nevill Mott

Cavendish Laboratory, University of Cambridge, U.K.

Book Review Editor

Dr E. Marseglia

Cavendish Laboratory, University of Cambridge, U.K.

Subscription Information

Published monthly Annual subscription 1985 £224 DM 1008 US \$620 ISSN 0141 8610

Dollar rates apply to USA, Canada and Mexico. Deutschmark rates to FR Germany. Sterling rates apply to the UK and all other areas.

All subscriptions are payable in advance and all rates include postage. Journals are sent by air to the USA, Canada and Mexico, India and Australasia. Subscriptions are entered on an annual basis, i.e. from January to December. Payment may be made by sterling cheque, dollar cheque, international money order or National Giro, or by credit card (AMEX, VISA, Mastercard/Access).

Orders originating in the following territories should be sent direct to the local distributors

USA, Canada and Mexico Taylor & Francis Inc, 242 Cherry Street, Philadelphia, Pennsylvania 19106 1906.

Japan Kinokuniya Company Ltd, Journal Department, PO Box 55 Chitose, Tokyo 156

India Universal Subscription Agency Pvt. Ltd, 117/H 1/294B Model Town, Pandu Nagar, Kanpur 208 025.

UK and all other territories Taylor & Francis Ltd, Rankine Road, Basingstoke, Hampshire RG24 0PR.

Air freight and mailing in the USA by Publication Expediting Inc, 200 Meacham Avenue, Elmont, New York 11003. Second class postage paid at Jamaica, New York 11431. US Postmaster: Send address changes to *Philosophical Magazine*, Publications Expediting Inc, 200 Meacham Avenue, Elmont, New York 11003.

Published by Taylor & Francis Ltd, 4 John Street, London WC1N 2ET, UK. Printed by Taylor & Francis (Printers) Ltd, Rankine Road, Basingstoke, Hampshire RG24 0PR, UK.

CONTENTS OF VOL. 51 Nos 1-6

NUMBER 1—JANUARY

PART A

	PAGE
Mobile dislocation density during the deformation of KCl single crystals By T. KATAOKA and J. C. M. LI	1
On the structure of {100} platelet defects in type Ia diamond By J. C. BARRY, L. A. BURSILL and J. L. HUTCHISON.....	15
Elasticity theory of a thin bicrystal distorted by an interfacial dislocation array parallel to the free surfaces By R. BONNET.....	51
Binding energy of hydrogen – impurity complexes in nickel By H. KRONMÜLLER and P. VARGAS.....	59
A dynamic lattice dislocation grain boundary sliding mechanism By K. READING and D. A. SMITH	71
Creep of Fe₂SiO₄ and Co₂SiO₄ single crystals in controlled thermodynamic environments By D. L. RICOULT and D. L. KOHLSTEDT	79
Brittle behaviour of ductile metals during stress-corrosion cracking By K. SIERADZKI and R. C. NEWMAN	95
Observation of dislocation sources in a quenched and stress-aged Al-4 wt% Cu alloy single crystal By A. SATO, Y. SUGISAKI and T. MORI.....	133
Relation between mobile dislocation parameters and orientation distribution function By K. WIERZBANOWSKI and A. CLEMENT.....	145
A model of creep at intermediate temperatures in aluminium By D. CAILLARD.....	157

PART B

Letters Section:

A model for the distribution of bond angles in vitreous SiO₂ By F. L. GALEENER.....	L1
--	----

	PAGE
Analysis of frequency-dependent loss data in amorphous silicon and germanium By N. BALKAN, P. N. BUTCHER, W. R. HOGG, A. R. LONG and S. SUMMERFIELD	L7
The electrical characterization of surfaces, interfaces and contacts to a-Si:H By R. A. STREET, M. J. THOMPSON and N. M. JOHNSON	1
The pre-exponential factor in the conductivity of amorphous silicon By N. F. MOTT	19
Analysis of dispersive transport in amorphous semiconductors by discretization of a continuous distribution of localized states By H. MICHIEL and G. J. ADRIAENSSENS	27
Frequency-dependent loss in sputtered amorphous germanium films. Measurements at low temperatures By A. R. LONG, W. R. HOGG, M. C. HOLLAND, N. BALKAN and R. P. FERRIER	39
Effect of hydrogenation on the conductivity of UHV-deposited amorphous silicon By P. A. THOMAS and J. C. FLACHET	55
Defect-controlled conductivity in As₂Se₃ single crystals By G. BRUNST and G. WEISER	67
Tunnelling and optical transitions at defects exhibiting large lattice relaxation By D. NINNO and M. JAROS	79
Announcement	

NUMBER 2—FEBRUARY

PART A

Letters Section:

Dislocations with $\langle 100 \rangle$ Burgers vectors in Ni₃Al By P. VEYSSIÈRE and J. DOUIN	L1
Labyrinth structure and persistent slip bands in fatigued 316 stainless steel By L. BOULANGER, A. BISSON and A. A. TAVASSOLI	L5
Creep and dislocation density of dispersion-strengthened materials By B. BURTON	L13
On the point of stoichiometric spinel, MgO·Al₂O₃ By B. C. DE COOMAN and C. B. CARTER	175
Toughening in WC-Co composites By V. D. KRSTIC and M. KOMAC	191

	PAGE
The metastable phases formed in amorphous Ni-P alloys during crystallization By K. H. KUO, Y. K. WU, J. Z. LIANG and Z. H. LAI.....	205
Solid solubilities in transition-metal-based f.c.c. alloys By M. MORINAGA, N. YUKAWA, H. EZAKI and H. ADACHI	223
Solid solubilities in nickel-based f.c.c. alloys By M. MORINAGA, N. YUKAWA, H. EZAKI and H. ADACHI	247
A comparative investigation of surface relief structures and dislocation micro-structures in cold-rolled aluminium By C. Y. BARLOW, B. BAY and N. HANSEN.....	253
Dislocation dynamics in anisotropic piezoelectric crystals By S. MINAGAWA and K. SHINTANI.....	277
Liposome structure and defects By J. A. ZASADZINSKI, L. E. SCRIVEN and H. T. DAVIS	287
Localized mode due to a vibrating dislocation in alkali halides By M. KAWANO, Y. H. OHASHI, M. FUKUCHI and K. OHASHI	303
Anomalous diffraction in thin gold films By M. JOSÉ-YACAMÁN, K. TRUSZKOWSKA, A. GÓMEZ, V. CASTAÑO and E. P. ZIRONI	315
Announcement.....	329

PART B

Special Issue

Theory of Localized Electronic States in Condensed Matter

Letters Section:

Determination of the extended-state electron mobility in a-Si By A. C. HOURD and W. E. SPEAR	L13
Counting constraints for hard disks By D. WEAIRE.....	L19
On the dielectric anomaly and clustering effects in dense mercury vapour By F. BROUERS and V. V. DIXIT.....	L21
The embedding problem in ordered and disordered systems By C. PISANI.....	89
Localized states in ionic crystals By J. M. VIAL.....	101
Theoretical studies of protons in sodium hydroxide By P. SAUL, C. R. A. CATLOW and J. KENDRICK.....	107

	PAGE
Calculations of interionic potentials in oxides	
By J. H. HARDING and A. H. HARKER	119
Hole localization in ionized and bound excitation states of monovalent copper halides	
G. J. M. JANSSEN and W. C. NIEUWPOORT	127
Ab initio calculations for impurities in Cu and Ni	
By P. H. DEDERICHs, R. ZELLER, H. AKAI, S. BLÜGEL and A. OSWALD	137
Self-consistent electronic structure of dilute metallic alloys by the LMTO-ASA method	
By P. LÉONARD and N. STÉFANOu	151
Defect calculations in semiconductors. Theoretical principles as illustrated by current calculations	
By A. M. STONEHAM	161
Defects in non-crystalline materials	
By N. F. MOTT	177
Defects in amorphous semiconductors	
By J. ROBERTSON	183
LUC-LCAO-CNDO calculations on covalent semiconductors	
By J. E. SZYMANSKI, P. V. SMITH and J. A. D. MATTHEW	193
Embedding calculations for deep impurity states in semiconductors	
By N. C. MILLER, P. M. LEE and J. E. INGLESFIELD	199
Chemisorption and the electronic structure of transition metal oxides and transition metals bonded to oxide surfaces	
By A. B. KUNZ	209
Surface states and the local electronic structure at surfaces	
By D. W. BULLETT	223
Ab initio cluster study of the chemisorption of oxygen on an aluminium (111) surface	
By R. BROER, I. P. BATRA and P. S. BAGUS	243
A model for electronic structure of VO₂	
By A. D. BURTON and P. A. COX	255
Book reviews	263

NUMBER 3—MARCH

PART A

Letters Section:

Precipitation kinetics under heavy-ion irradiation in CuBe

By R. KOCH	L19
------------------	-----

	PAGE
The elastic interaction between a symmetric point defect and a disc cluster in anomalous anisotropic cubic crystals: niobium By LI-TAI LU, E. CHOW, and G. SINES	331
Calculated asymmetry for weak beam intrinsic stacking fault images By A. R. WILSON and D. J. H. COCKAYNE.....	341
Electron microscope images of dislocations meeting a free surface By P. HUMBLE	355
The anomalous strength peak and the transition of slip direction in β-CuZn By H. SAKA, Y. M. ZHU, M. KAWASE, A. NOHARA and T. IMURA	365
Radiation defects in Te-implanted germanium. Electron microscopy and computer simulation studies By M. G. KALITZOVA, D. S. KARPUZOV and N. K. PASHOV	373
The displacement field of a triangular dislocation loop By D. M. BARNETT.....	383
On elastic relaxation and long wavelength microstructures in spinodally decomposed $\text{In}_x\text{Ga}_{1-x}\text{As}_y\text{P}_{1-y}$ epitaxial layers By M. M. J. TREACY, J. M. GIBSON and A. HOWIE.....	389
Coherence of inelastically scattered fast electrons in crystals of finite thickness By S. DONIACH and C. SOMMERS.....	419
On the use of Somigliana dislocations to describe some interfacial defects By R. BONNET, G. MARCON and A. ATI.....	429
Recovery of edge-defined film-fed grown silicon. Dislocation/twin boundary interaction and mechanisms for twin-induced grain boundary formation By R. GLEICHMANN, M. D. VAUDIN and D. G. AST.....	449
On the presence of superlattice intrinsic stacking faults in plastically deformed Ni_3Al By P. VEYSSIÈRE, J. DOUIN and P. BEAUCHAMP	469
Plasticity at crack tips in $\text{Gd}_3\text{Ga}_5\text{O}_{12}$ garnet single crystals deformed at temperatures below 950°C By H. GAREM, J. RABIER and S. H. KIRBY.....	485
Addendum: Ferroelastic character and study by HREM of the mechanism of the hexagonal-monoclinic phase transition of rare earth sesquioxides By M. BEN SALEM, R. DORBEZ, B. YANGUI and C. BOULESTEIX.....	497

PART B

Letters Section:

Microscopic model of the Staebler-Wronski effect in intrinsic amorphous hydrogenated silicon By L. E. MOSLEY, M. A. PAESLER and I. SHIMIZU.....	L27
---	-----

	PAGE
Density of states study of sputtered and evaporated a-Si:H by space-charge-limited current technique By S. GANGOPADHYAY, S. ISELBORN, H. RÜBEL, B. SCHRÖDER and J. GEIGER	L33
Non-metal-metal transition in molten potassium-potassium-halide solutions By G. SENATORE and M. P. TOSI.....	267
Transient photocurrents in a-Si:H and weak electron-phonon coupling processes By T. KAGAWA and N. MATSUMOTO.....	273
Infrared investigations of hydrogenated amorphous silicon. I. Inductive spectral shifts as predicted from monomer data By E. SACHER	285
Infrared investigations of hydrogenated amorphous silicon. II. The existence of polysilane, (SiH₂)_n By E. SACHER	295
The structure of molten CsCl By J. LOCKE, S. MESSOLORAS, R. J. STEWART, R. L. MCGREEVY and E. W. J. MITCHELL	301
Mass density of liquid tellurium under high pressure By R. BARRUE and J. C. PERRON.....	317
Structure and short-range order of vapour-deposited Si_{1-x}Sn_x amorphous alloys By M. VERGNAT, M. PIECUCH, G. MARCHAL and M. GERL.....	327
Electronic transport and ionic migration in molten Na-K and Na-Rb alloys By G. C. BARKER and W. JONES.....	337
Determination of localized state distributions in amorphous semiconductors from excess charge carrier thermalization By J. WEISSMÜLLER.....	349
Book reviews	363

NUMBER 4—APRIL

PART A

Letters Section:

Radiation damage and non-equilibrium phases in Al₂O₃ By W. E. LEE, K. P. D. LAGERLOF, T. E. MITCHELL and A. H. HEUER	L23
A method to determine surface free energies from cavity radius distributions By L. MARTINEZ and J. H. SCHNEIBEL	L29

	PAGE
Effect of physical ageing on the mechanical relaxation of a chalcogenide glass By S. ETIENNE, J. Y. CAVAILLE, J. PEREZ and G. P. JOHARI	L35
Atomic structure of (001) twist boundaries in f.c.c. metals. Structural unit model By D. SCHWARTZ, V. VITEK and A. P. SUTTON	499
Martensitic transformations in single crystals of 1,20-eicosanedioic acid, $\text{HOOC}(\text{CH}_2)_{18}\text{COOH}$ By T. ASAH, M. KONDO, T. OGAWA, K. IZUMI, H. MIYAJI and K. ASAI	521
An analysis of the effect of multiaxial stresses and grain shape on Nabarro-Herring creep By G. W. GREENWOOD	537
The classification of mixed close-packed clusters of substitutional point defects in crystals By A. Q. MALIK, J. I. AKHTAR, S. A. AHMAD and A. G. CROCKER	543
The structures and energies of small clusters of vacancies and substitutional solutes in body-centred-cubic metals By A. Q. MALIK and A. G. CROCKER	551
Effect of stress reduction ratio on the creep behaviour of Al By F. A. MOHAMED, M. S. SOLIMAN and M. S. MOSTAFA	559
High-spatial-resolution STEM analysis of transition micro-phases in Al-Li and Al-Li-Cu alloys By P. SAINFORT and P. GUYOT	575
Rigid-body displacements at $\Sigma 9$ grain boundaries By C. T. FORWOOD and L. M. CLAREBROUGH	589
<i>In situ</i> deformation of the γ' hardened superalloy Nimonic PE16 in high-voltage electron microscopes By E. NEMBACH, K. SUZUKI, M. ICHIHARA and S. TAKEUCHI	607
Anomalous slip in high-purity tantalum single crystals after tensile deformation at 77 K By W. WASSERBÄCH	619
Climb dissociation of $\langle 111 \rangle$ superdislocations in β-CuZn By H. SAKA and Y. M. ZHU	629

PART B

Letters Section:

The nature of the Si-O-Si bond angle distribution in vitreous silica By P. G. COOMBS, J. F. DE NATALE, P. J. HOOD, D. K. McELFRESH, R. S. WORTMAN and J. F. SHACKELFORD	L39
--	-----

	PAGE
X-ray diffraction analysis of molten CdCl_2-type layer structures	
I. CoCl_2	
By Y. TAKAGI and T. NAKAMURA	L43
Defect luminescence and its excitation spectra in As-doped Se single crystals	
By H. LUNDT and G. WEISER	367
The shape of cobalt precipitates in copper	
By P. KOURNETTAS, K. STIERSTADT and D. SCHWAHN	381
Surface-field measurements in low-mobility semiconductors	
By P. B. KIRBY, D. W. MACLEOD and W. PAUL	389
Application of the recursion method to pseudopotential band-structure calculations	
By K. MASCHKE	397
Electrical behaviour of chemically modified amorphous Se studied by xerographic depletion discharge	
By M. ABKOWITZ, F. JANSEN and A. R. MELNYK	405
Dynamic vortex pinning in a type II superconductor	
By M. G. BLAMIRE and J. E. EVETTS	421
A model for the behaviour of the Hall coefficient in amorphous and liquid transition metals	
By M. A. HOWSON and G. J. MORGAN	439
Quantum diffusion and localization in disordered systems	
By M. KAVEH	453
An angle-resolved X-ray photoelectron spectroscopic study of air-oxidized UO_2 pellet surfaces	
By G. C. ALLEN	465
Book reviews	475

NUMBER 5—MAY

PART A

Letters Section:

The nature of the cores of composite particles formed in a Li-containing aluminium alloy	
By P. L. MAKIN, D. J. LLOYD and W. M. STOBBS	L41
Differential scanning calorimetric study of quenched-in vacancies in NiAl	
By M. SHIMOTOMAI, T. IWATA and M. DOYAMA	L49

	PAGE
The shape of Shockley partial dislocations in the process of forming a stacking-fault tetrahedron By LIU BEN-LIN and WANG HAI-DA.....	L55
The influence of helium doping on the damage microstructure of heavy-ion irradiated α-Al₂O₃ By W. E. LEE, M. L. JENKINS and G. P. PELLIS	639
The mechanism of dislocation climb in GaAs under electron irradiation By D. CHERNS and G. FEUILLET.....	661
<i>In situ</i> TEM observations of the cyclic dislocation behaviour in persistent slip bands of copper single crystals By J. LEPINOUX and L. P. KUBIN	675
Study of $\Sigma=5$ ($\bar{1}\bar{3}0$) symmetrical tilt boundary structure in germanium By J. J. BACMANN, A. M. PAPON, M. PETIT and G. SILVESTRE	697
Biais des dislocations dans les alliages dilués Par P. VALENTIN et G. MARTIN	715
Interpretation of atomic-resolution electron microscope images of Guiner-Preston zones in aluminium-copper alloys By N. AJIKA, H. ENDOH, H. HASHIMOTO, M. TOMITA and H. YOSHIDA.	729
The formation and evolution of edges on sputter-eroded surfaces By G. CARTER and M. J. NOBES.....	745
On grain boundary strength in sintered Al₂O₃ By A. KRELL, J. WOLTERS DORF, E. PIPPEL and D. SCHULZE	765
Addendum: The thermodynamics of mixed oxide reactor fuels By C. R. A. CATLOW and P. W. TASKER	777
Erratum: Dislocation loops in elastically anisotropic materials. I. Small loops in β-brass By A. J. MORTON	779

PART B

Letters Section:

Transient photoconductivity and demarcation energies in amorphous semiconductors By V. HALPERN.....	L49
Reply to 'The effect of temperature-dependent energies on semiconductor thermopower formulae' By D. EMIN	L53

	PAGE
Luminescence spectroscopy of CsI:Ti⁺ By V. S. SIVASANKAR and P. W. M. JACOBS	479
Excited state absorption and energy transfer in the infrared laser material MgF₂: Ni²⁺ By R. MONCORGÉ, F. AUZEL and J. M. BRETEAU	489
Sodium-tungsten bronze thin films. I. Optical properties of dilute bronzes By M. GREEN and A. TRAVLOS	501
Sodium-tungsten bronze thin films. II. Electrical properties of dilute bronzes By M. GREEN and A. TRAVLOS	521
Calculations of the mean width of the Coulomb gap in disordered systems by two simple methods By M. ORTUÑO and M. POLLAK	533
Spin-glass transition in a magnetic field By H. SOMPOLINSKY.....	543
Radiation damage in an amorphous Lennard-Jones solid. A computer simulation By T. K. CHAKI and J. C. M. LI	557
Book reviews.....	567
Erratum: Effect of hydrogenation on the conductivity of UHV-deposited amorphous silicon By P. A. THOMAS and J. C. FLACHET	569

NUMBER 6—JUNE

PART A

Letters Section:

Flow stress and positron traps during the hardening stage in cyclically deformed copper By L. DÍAZ, R. PAREJA, M. A. PEDROSA, J. I. PRIETO and R. GONZÁLEZ	L61
Plastic deformation of GaAs single crystals at room temperature and the influence of doping By J. RABIER, H. GAREM, J. L. DEMENET and P. VEYSSIÈRE.....	L67
A new approach to diffusion-induced grain boundary motion By N. LOUAT, C. S. PANDE and B. B. RATH	L73
The radius of curvature of dislocation segments in MgO crystals stressed in the high-voltage electron microscope By U. MESSERSCHMIDT, F. APPEL and H. SCHMID.....	781

A theoretical study of the formation and aggregation of vacancy-impurity dipoles in divalently doped alkali halide crystals By N. M. BANNON, J. CORISH and P. W. M. JACOBS	797
Study of the phase difference associated with the contrast of displacement fringes in the electron microscopy of platelike precipitates By Y. BOUAZRA and F. REYNAUD.....	815
Domain structures of tetrahedrally close-packed phases with juxtaposed pentagonal antiprisms. I. Structure description and HREM images of the C14 Laves and μ phases By H. Q. YE, D. X. LI and K. H. KUO	829
Domain structures of tetrahedrally close-packed phases with juxtaposed pentagonal antiprisms. II. Domain boundary structures of the C14 Laves phase By H. Q. YE, D. N. WANG and K. H. KUO	839
Domain structures of tetrahedrally close-packed phases with juxtaposed pentagonal antiprisms. III. Domain boundary structures in the μ phase By D. X. LI and K. H. KUO	849
The sweep-up model of charged dislocations in ionic crystals By R. W. WHITWORTH.....	857
Ecarts à la loi d'Arrhenius dans l'autodiffusion du thallium cubique centré (β-Tl) Par R. CHIRON et G. FAIVRE	865
Screw dislocation networks generated in Ge and Si by stage IV compression By H. G. BRION and P. HAASEN.....	879
Dipole tensors and changes in elastic constants produced by defects in ionic crystals By M. P. PULS.....	893
Erratum	913
Subject index	915
Index of authors (with titles).....	921
List of contents	iii

PART B

Letters Section:

The pre-exponential factor in the conductivity of undoped hydrogenated amorphous silicon By R. MEAUDRE	L57
Role of dopants in pressure-induced effects in glassy GeSe_{3.5} containing Bi and Sb By K. L. BHATIA, G. PARTHASARATHY, D. P. GOSAIN and E. S. R. GOPAL	L63

Dislocations without deep states in α-quartz By M. HEGGIE and M. NYLÉN	L69
Electronic structure of α-quartz, the $[10\bar{1}0]$ surface and perfect stoichiometric dislocations By M. HEGGIE, R. JONES and M. NYLÉN	573
Influence of carbon incorporation in amorphous hydrogenated silicon By M. P. SCHMIDT, J. BULLOT, M. GAUTHIER, P. CORDIER, I. SOLOMON and H. TRAN-QUOC	581
Photoconductivity and photoluminescence and their relation to light-induced ESR in $(\text{Ge}_{0.42}\text{S}_{0.58})_{1-x}(\text{Sb}_{0.4}\text{S}_{0.6})_x$ glasses By M. KUMEDA, G. KAWACHI and T. SHIMIZU	591
Study and analysis of structural properties of non-crystalline carbon phases prepared from PTFE By L. ČERVINKA, F. P. DOUSEK and J. JANSTA	603
Vacancy formation parameters from isoelectric temperatures in calcium-doped potassium chloride By J. L. TALLON, R. G. BUCKLEY, M. P. STAINES and W. H. ROBINSON	635
The relationship between optical gap and chemical composition in chalcogenide glasses By M. YAMAGUCHI	651
Book reviews	665
Subject index	669
Index of authors (with titles)	675
List of contents	iii

THEORY OF THE EARTH AND ITS HISTORY

1. The Earth is a sphere, and its surface is covered by water and land. The land is divided into continents and islands. The water is divided into oceans and seas. The Earth is surrounded by a thin layer of air, called the atmosphere. The atmosphere is divided into layers, called the troposphere, stratosphere, mesosphere, and thermosphere. The Earth is also surrounded by a thin layer of water, called the hydrosphere. The hydrosphere is divided into oceans, seas, rivers, and lakes. The Earth is also surrounded by a thin layer of fire, called the lithosphere. The lithosphere is divided into continents and islands. The Earth is also surrounded by a thin layer of life, called the biosphere. The biosphere is divided into plants and animals.
2. The Earth is a sphere, and its surface is covered by water and land. The land is divided into continents and islands. The water is divided into oceans and seas. The Earth is surrounded by a thin layer of air, called the atmosphere. The atmosphere is divided into layers, called the troposphere, stratosphere, mesosphere, and thermosphere. The Earth is also surrounded by a thin layer of water, called the hydrosphere. The hydrosphere is divided into oceans, seas, rivers, and lakes. The Earth is also surrounded by a thin layer of fire, called the lithosphere. The lithosphere is divided into continents and islands. The Earth is also surrounded by a thin layer of life, called the biosphere. The biosphere is divided into plants and animals.
3. The Earth is a sphere, and its surface is covered by water and land. The land is divided into continents and islands. The water is divided into oceans and seas. The Earth is surrounded by a thin layer of air, called the atmosphere. The atmosphere is divided into layers, called the troposphere, stratosphere, mesosphere, and thermosphere. The Earth is also surrounded by a thin layer of water, called the hydrosphere. The hydrosphere is divided into oceans, seas, rivers, and lakes. The Earth is also surrounded by a thin layer of fire, called the lithosphere. The lithosphere is divided into continents and islands. The Earth is also surrounded by a thin layer of life, called the biosphere. The biosphere is divided into plants and animals.
4. The Earth is a sphere, and its surface is covered by water and land. The land is divided into continents and islands. The water is divided into oceans and seas. The Earth is surrounded by a thin layer of air, called the atmosphere. The atmosphere is divided into layers, called the troposphere, stratosphere, mesosphere, and thermosphere. The Earth is also surrounded by a thin layer of water, called the hydrosphere. The hydrosphere is divided into oceans, seas, rivers, and lakes. The Earth is also surrounded by a thin layer of fire, called the lithosphere. The lithosphere is divided into continents and islands. The Earth is also surrounded by a thin layer of life, called the biosphere. The biosphere is divided into plants and animals.
5. The Earth is a sphere, and its surface is covered by water and land. The land is divided into continents and islands. The water is divided into oceans and seas. The Earth is surrounded by a thin layer of air, called the atmosphere. The atmosphere is divided into layers, called the troposphere, stratosphere, mesosphere, and thermosphere. The Earth is also surrounded by a thin layer of water, called the hydrosphere. The hydrosphere is divided into oceans, seas, rivers, and lakes. The Earth is also surrounded by a thin layer of fire, called the lithosphere. The lithosphere is divided into continents and islands. The Earth is also surrounded by a thin layer of life, called the biosphere. The biosphere is divided into plants and animals.